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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a **PROVISIONAL APPLICATION FOR PATENT** under 37 CFR 1.53 (b)(2).

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TITLE OF THE INVENTION (280 characters max)

BATTERY SAVING IR RETROMODULATION FOR REMOTE IDENTIFICATION; WIFI INTERFACE AND MAV COMMUNICATION

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Respectfully submitted,

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

Battery saving IR retromodulation for remote identification; WiFi interface and MAV communication.

Inventors – Michael Slatkine; Nir Karasikov; David Tamir; Amir Ben-Shalom

Assignee – IRALink Ltd.

Field of the invention

The field of invention is infrared communication in general.
More particularly, the field of the invention is wireless low energy consumption communication between a battery limited user, which wants to transmit information to a station which is not energy limited, and even more particularly wireless communication with optical retro modulators. The field of the invention covers the applications of energy saving Internet wireless communication, remote TV controllers, remote energy saving electronic biometric based identification cards and miniature airborne vehicles.

Background of the Invention

The use of IR communication in portable devices is becoming more popular. Many new devices with IR communication ports are being introduced, among them Palm computers, Cellular telephones, computer keyboards etc. and the number of applications, for such devices, that make use of the IR port are increasing. In many such applications, information download from portable devices to stationary devices is facilitated. Many of the devices using IR communication are portable, which means to say battery powered, devices, rendering it important that the IR port is efficient in its power consumption. Increasing use of IR communication in portable devices, by the various applications increases the importance of low power consumption during communication, thus allowing longer spells of use before having to re-charge the device's batteries.

The standard IR port today comprises one or more IR diodes mounted in the portable device, which transmit information using one of the known communication protocols. Such a means of transmitting is adequate for occasional use, but, as IR transmission using current in the order of milliamps, frequent use of the port may be expected to limit the duration between re-charges. Battery capacity thus acts as a limitation on the freedom of applications to make full use of the IR port.
An IR interface to the new and growing WiFi network is a major part of the present invention. As important is the communication to miniature devices such as smart cards where the battery capacity is extremely limited or to moving miniature objects such as nano-robots or MAVs (miniature airborne vehicles) where communication consumes energy and battery volume and an introduction of a low power IR communication can be extremely beneficial. TV, IR based, remote controls that use

minimal energy and could be operated on a solar cell w/o a battery is yet another aspect of the present invention.

Description of the figures

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Description of PDA battery energy saving wireless communication system

An important application of the current invention is in the area of wireless Internet communication between portable digital assistants (PDA) such as desktop computers, PALM organizers or cellular phones and Internet providers. There is a wide interest in sending or reading e-mails or surfing the web from locations, which are far from a wall Internet connector. Such locations may be a seat in an air port terminal, a comfortable chair at home, a table in a café house .A current solution for wireless communication between PDA devices or PDA and internet connectors is the "Bluetooth" technology which is based on microwaves. "Bluetooth" technology is effective for distances shorter than 10-30 meters. The two major disadvantages of "

Bluetooth" are: a) there is a possibility of cross talk between microwaves channels, resulting in lack of security. b) The Bluetooth technology consumes high battery power level (often close to 100 milliwats), resulting in very fast depletion of batteries in PDA. The fast depletion of PDA batteries is a major problem in out of office use of PDA and solving that problem is a major objective of the current invention. A strongly related modality is called WiFi (Wireless Fidelity), which is a microwave local area network (LAN) communication channel operating at 2.4 GHz. A second wireless communication technology for PDA is infrared communication, whether direct or diffused. Battery consumption is high with infrared technologies since a LED transmitter is incorporated in the PDA and both the infrared carrier and the modulation process consume energy from the batteries. The infrared carrier consumes much more than the modulator.

The current invention enables the establishment of wireless Internet communication with very low PDA battery energy consumption.

Local Area Network:

In one embodiment of the current invention, a local area network is established by connecting a retro modulator 2 in figure 10 to a PDA 1 with a connector such a USB connector. The retro modulator is described in details later on, see figure 11.

The PDA is located in any convenient working place in a room or hall. A transceiver 3, which may stand on a stand 8 is located in any convenient site in the room and fed by an electrical cord 9 plugged in a 110 V or 220 V supply. The transceiver 3 is a spherical transceiver, which consists of a multitude of segments (between 1 and a few hundreds). Each segment radiates continuous infrared radiation, which is diffused by a diffuser and spans a diffused angle THETA. The radiation covers an area of limited size at a distance R. The radiation from the array of transceiver segments covers the entire space (floor). A PDA operated by a user located any where in the room (or café house or air port terminal for example) will receive radiation from some particular segment of the transceiver. As an example, the transceiver may be a 10 cm " spherical" transceiver which consists of approximately 300 segments, each segment spanning a solid angle 4PI/300 ~ 1/25 steradian, or ~ 12 degrees. The radiation pattern 6 in the vicinity of the PDA will have a diameter of 3 meters/ 6 = 50 cm if the PDA is located at a distance of 3 meters from the transceiver. The entire room or hall will be covered by radiation patterns generated by the multitude of transceiver segments. The shape of the segments may vary. In one of the embodiments, the diffusing element is a hemisphere, which covers an array of transmitters.

Some of the radiation 7 emitted from the transceiver will reach the retro modulator 2 and be retro reflected back to the specific segment on 3, which has emitted the radiation. The beam received by the transceiver segment is sent to a detector in the transceiver, which demodulates the signal and transmits it via a standard WiFi channel 12 or other channel such as diffused infrared to the Internet connector 14. The reflected beam 7 is modulated by the very low power modulator 2 and carries the information, which the PDA user wants to transmit, such as an e-mail. The downstream information from the Internet connector is preferably transmitted by a standard state of the art WiFi microwave or diffused infrared channel, which is attached to the wall in the vicinity of the Internet connector or to the transceiver. There is no need to save energy in the transceiver site. In another embodiment of the invention the down stream beam 7 is both a carrier for the retro modulated beam and may also carry information from the internet provider to the PDA. That embodiment will be rarely applied.

A low power system (LAN) as described above may consist of a PALM or laptop computer with a retro modulator 1X3 cm size. Channel bandwidth may be 100 kbit/seconds. The retro modulator is attached to the PDA with a standard connector. The transceiver lamp is a 10 cm lamp, which looks like an illuminating lamp and is located in a convenient place in the room, which may be a domestic home, or a café or a terminal hall.

In cases of large volume halls such as airport terminals, more than one transponder (transceiver) is available. Transponders may be located in many convenient locations in a terminal so that each point in the terminal is covered by at least one segment of one transponder.

The retro modulator:

Figure 11 presents a variety of configurations of retro modulators. Figure 11 a presents the basic retro modulator configuration. A lens 21 is attached to an assembly socket 22. A liquid crystal shutter 23 is connected to wires 25 which are fed by a modulating signal 26, which is generated by the PDA user. A mirror 24 is located behind the shutter 23. A beam 7, which hits the assembly, is retro reflected and modulated.

The lens 21 may be 1 -25 mm diameter, and transparent to infrared radiation at 810 nm -1600 nm. Other wavelengths may be utilized as well. The selection of wavelength is the result of a trade off between eye safety,(1500 nm is safest) , cost of transmitter power source (may attain several watts which may be too expensive at 1500 nm and leads to 800-980 nm) and detector (in the transceiver) sensitivity and noise level. The level of background radiation from ambient light sources is a source of noise to the detector in the transceiver and may also affect the selection of the operating wavelength.

The lens F-number may be 1.5. This assures a wide viewing angle close to 60 degrees. The modulator 23 may consist of a fast liquid crystal shutter such as a PDLC (polymer diffuser liquid crystal) which switches the device from a diffuse state to a transparent state or from transparent to diffused. Such shutters are inexpensive A shutter may be produced by modifying the size of PDLC produced for example by 3M. The switching time is ~ 100 kbits/seconds which is adequate for the majority of Internet applications. The shutters may be obtained from CRL – Central Research Laboratory. Another alternative is the use of liquid crystal plates produced by 3M, Crystaloid or other manufacturers. Figure 11a also shows wires through which the modulated signal 26 is fed.

In another embodiment of the invention the modulation is not performed by a liquid crystal but rather by a " MEMS' mechanical modulator which is described in patent application PCT/1L01/00945:

Preferably, said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infrared port and the device associated with said remote port is a fixed device.

Preferably, said modulator comprises a capacitive microphone.

Preferably, said modulator comprises a piezoelectric transducer.

Preferably, said reflector comprises a reflecting layer. Alternatively or additionally, said reflector comprises a liquid crystal unit.

Preferably, said reflecting layer comprises stripes of reflecting material interspersed with non-reflecting material.

Preferably, said reflecting layer is superimposed on a second layer comprising stripes of non-reflecting material interspersed with transparent material.

Preferably, said reflecting layer is a substrate (glass or polymer) doped with nano particles that can change the optical properties.

Preferably, said modulator is based on changing transmission and not reflection.

Preferably, said change of transmission is a PDLC (Polymer dispersed liquid crystal).

Preferably, said modulator comprises a piezoelectric actuator associated with one of said layers to cause relative motion between said reflecting layer and said second layer.

Preferably, said piezoelectric actuator is located laterally of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Preferably, said piezoelectric actuator is arranged to cause bending of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Figure 11b shows a lenslette array 27 of "cat eye" lenses. An example is by Fresneltech. That configuration enables the use of thin retro modulators, which are more convenient. The modulating signal is also shown. The lenslette array may be similar to those produced by Fresnel Optics corp, USA.
When the field of view of the retro modulator is too narrow and beam 7 is only partially reflected to the transceiver, it is possible to rotate the retro modulator around an axis 29 in order to enhance channel effectiveness. A few panels of lenslette retro modulators may be utilized as in figure 11c.The number of panels may vary. Figures 11c and 11d show adjustable configurations. The lenslette array may be planar or hemispherical 30. Many other configurations are possible. Adjusting angle may be performed by axial rotation or on a spherical pivot. Figure 11e shows another configuration whereby the retro modulator panel 31 is attached to the PDA through a semi flexible cable 32.
In figure 12 we show a retro modulator, which is designed to increase the channel operating bandwidth by X2. The retro modulator consists of two parts , each part is covered with a narrow band pass optical filter 50 at different wavelengths w1 and w2. Each part is modulated by a different liquid crystal 51 and 52 with different information 53 and 54, each with a bandwidth Df1 and Df2. Each part will retro reflect light 54 at different wavelengths transmitted by two sources in the transceiver. As a result, it is possible to operate at a larger bandwidth Df1 + Df2.
There is a trade off between bandwidth and operating range. Doubling the bandwidth by reducing the reflecting area of each channel by a factor X2 reduces the receiver power by a factor X2. This results in the reduction of range by a factor 2^1/2.

The transceiver

Figure 13 a is an outer view of the transceiver. The general shape is a sphere if used as a portable "lamp" in a room or a hemisphere if fixed on the ceiling. It consists of an

array of segments 70, each segment radiating diffused radiation from a diffuser. As a result, each segment spans an angular beam of divergence THETA.
The diffusivity of the diffuser may typically be 10 degrees, which is easily achieved with plastic (such as polycarbonate) or glass by sandblasting them or etching them with an acid such as fluoric acid HF.
Referring to figure 13b, the power generated by a diode or a lamp 71 is selected in a way to assure that the power density emitted from the diffuser is eye safe and complies with ANSI Z 136.1 standard. By operating the diode for a duration T (seconds), the maximum permitted radiance M is given by M = 10 k1*k2 Joules/cm2 steradians, where k1=1, k2 depends on wavelength. K2 ~ 1.5 at 980 nm. Assuming communication duration of 10 seconds followed by an intermission leads to a power density level of 1 watts / cm2 / strad. . Assuming 10 degrees diffuser (~1/6 radian, PI/100 steradian) and a 2 cm diameter segment (4 cm2 area) , we obtain a power level of ~ 150 milliwatts . A typical power level emitted by the source of a single segment 71 is 0.15 watts, and the diameter of a segment 70 is 1-3 cm. An array of 200 segments will radiate ~ 30 Watts. (The transponder will act as an IR eye safe " spherical" lamp of 30 watts power level , with a surface area of ~ 300 cm2.
Figure 13b depicts the configuration of a transceiver segment in one embodiments of the invention. The transmitter is enclosed in an enclosure 72.
The radiation source 71 may be a diode or a diode stack, which typically emits monochromatic light at any wavelength between 750 nm and 1500 nm. The diode may be cooled if necessary. 1 watts infrared diodes can be purchased for example from Agilent USA. In another embodiment the light source may also be a halogen lamp with a narrow band filter or a Krypton gas discharge lamp, which emits a few peaks in the infrared and may be purchased from ILC or Hereaus Germany. It is also possible to use a high power source which feeds a multitude of fibers or light guides, which split into many smaller fibers, each serving as the source 71 for some segment. The emitted light 74 is diffused by the diffuser 70 and transmitted as diffused light 77 to the space in the room. A beam splitter 75 is located in front of the emitter. 75 may also serve as a filter 76. The retro reflected light 78 is bounced by the beam splitter 75 to a receiver lens 80 into a detector 82. A narrow band pass filter 81 rejects ambient radiation at any wavelength, which is not within the emission spectrum of the source (such as LED) 71. This reduces ambient shot noise in the detector 82. A typical band pass filter 80 will have a 20 nm bandwidth with a central bandwidth between 750 nm and 1500 nm. Such filters are available from Edmund, USA. The photodiode 82 may be a Si photodiode or a Si avalanche photodiode or other semiconductor photodiodes, which are sensitive to wavelength up to 1500nm.
The diameter of the photodiode should be large enough to receive radiation reflected from a retro modulator located in an area covered by the segment to which it belongs. The larger the diameter, the wider the detection field of view. On the other hand, the larger the detector, the higher the shot noise generated by the detector and the lower the signal to noise ratio and the quality of the communication channel. By minimizing the F-number of the receiving lens 80, it is possible to reduce detector diameters. A typical lens diameter 80 is ~ 1cm, and the F-number ~ 1. The typical diameter of the detector for a field of view 10 degrees (~ 1/6 of a radian) is ~ 1.5 mm. A 1.5 mm detector may generate a lower than 10 nano Amper dark current.
The output signal 83 from the detector 82, which carries the information generated by the PDA user, is fed to a WiFi transmitter and sent to the Internet connector.

Figure 14a and figure 14 b show a different embodiment whereby the segments on the transceiver are divided into radiating segments 90 and receiving segments 91. The radiated light patterns 93 from the radiating segments on the floor are overlapping 94. As a result, a PDA 95 will be able to communicate with the transceiver and the receiver 96 will not block radiation emitted from the radiating segments. The beam splitter 97 will divert the retro reflected beam 98 toward the receiver.
Figure 14c presents a concentric " Cassagrain " type transceiver. In that configuration the emitter 71 is located in front of a small convex mirror 501. The emitted rays 74 are reflected toward a concave mirror 502 and reflected again toward the diffuser 70. As a result an eye safe diffused beam 77 is created with a diverging angle THETA. The receiver is located on the other side of the convex mirror. A lens 80 collects the retro reflected beam 78 into a Si photodiode 82.

In another embodiment of the invention there is an effort to minimize the energy radiation from the transceiver. That effort may generally improve the eye safety of the transceiver of the energy consumption in the case of a multitude of transceivers, which may be used in an airport terminal for example.
The various transceiver segments radiate diffused light with a small power level, such as only 10 milliwatts. When a retro reflector is present, one receiver will detect retro reflected light and the presence of the retro reflector. A microprocessor will provide a command to the corresponding radiator source to increase the power emitted by it. As a result, only a segment, which communicates with a retro reflector, is fully activated an eye safety is enhanced.

In another embodiment of the invention, the radiators in each segment are modulated at a high frequency such as 1 MHz. That high frequency enables the detector to avoid ambient low frequency optical noises such as originating from fluorescent lamps.
In another embodiment of the invention, the retro modulator modulates the retro reflected light at a constant frequency, which enables avoiding ambient light interference.

Using a retro modulator for battery energy saving in remote controllers of devices such as TV sets or TV toys or home appliances.

The method and apparatus described above may be utilized for energy saving in remote controllers of devices such as TV sets. Current TV controllers utilize LED, which actively irradiate light toward a receiver in the TV and modulate the light with the information on program selections. Most of the battery energy is spent on the light emission. The frequent need to change batteries in TV controllers is inconvenient and it would be preferable to utilize a controller, which consumes very low battery power. In one embodiment (see figure 15) of the low consumption TV (or other devices such as TV games or home appliances) controller, a transceiver 110 is located in the room or usually on or inside the TV set 111 and the controller 112 incorporates a retro reflector 113, which modulates light 114 emitted from the transceiver. The configuration is similar to the Internet case described above. The emitter radiates very low light level radiation. The light level is increased whenever the receiver (in the transceiver) detects retro reflected light which indicates the intention to use the controller. The information sent by the TV user modulates the light retro reflected from the retro reflector in the controller. As a result, energy is wasted only on

modulation. The bandwidth utilized in a retro modulator controller is usually much smaller than utilized in the Internet embodiment. It may be as low as 10 bits / sec. As a result infrared radiation level from the TV may be very low and energy saving is even better than in the Internet case. An additional embodiment uses a solar cell in the Remote Controller and a charger such that the Remote Controller does not need a battery at all. In another embodiment, the IR radiation of the transceiver illuminates the solar cell to generate the required electric energy for the remote controller.

Using the retro modulator in conjunction with electronic remote identification cards

The invention can be utilized also for the production of energy saving remote identification cards, which utilize personal biometric information. The person to be identified will hold an identity card in which biometric information such as voice features or facial features, or fingerprint data or skin conductivity data will be stored. In order to save batteries in the identification card, a transceiver located in the protected site will detect retro modulated light from the card to be presented and compare the information to data acquired in real time. A preferred embodiment also enables to detect efforts to falsify the card or distort biometric data.

The problem

The protection of public places today, is done by a security guard with a metal detector at the gate. There were multiple cases where the guard failed to remotely detect a suspicious person, ending up with a fatal attack taking the lives of the guard as well as many innocent citizens.
A remote and early detection provision would give a few extra critical seconds, in which the guard can act and prevent the terrorist attack. Furthermore, the validation via biometric features remotely, allows better routine access control to institutes or special events. A few examples are: hospitals; restricted zones in airports; large-scale conventions; the forthcoming Olympic games etc.
A longer-term opportunity is for a smart ID card containing the relevant information on the holder. The US requirement for a Visa with biometric validation is an excellent opportunity in this respect.

The solution

The invention describes a "smart card" containing the holder's essential identification details as well as biometric characteristic information such as a coded fingerprint, a voice formant or some invariant morphometric feature. The card is the size of a standard credit card or has the shape and size of a pen. Using the Retro modulated IR communication technology of the present invention, embedded in the smart card, the card would be able to transmit this characteristic data to a remote distance of 5 or more meters, consuming negligible power. At this remote location a processor would compare the characteristic data to the voice or face features of the person. Only upon positive verification would the person be allowed to approach. In case of no

identification, the approaching person would have to go through a separate route including a comprehensive check.

Technical description (described also in Fig 5):

The steps in the identification process are as follows:

1. A person is approaching a public place.
2. At 5 –30 meters from the guard he is stopped at a barrier for identification.
3. The approaching person presents the SAFETY – 1, smart card.
4. The card transmits, using the low power PMRF, the coded information, detected by a simple processor near the guard.
5. The approaching person spells his name and the verification system, based on the voice formants or on other invariant biometric features.
6. The Safety – 1 compares the IR transmitted data to that actually measured.
7. Upon positive verification, the person can approach the guard.
8. In case of no identification, the approaching person is guided to a separate, more remote location for a thorough search.
9. In the case of a card, which is based on voice identification, it is possible to request from the card user to answer a question posed by the guard. Changes in voice features will allow detecting an effort to lie.

Advantages

- Remote verification of an approaching person
- A small, standard dimension, card for extended operation
- An advanced communication technique, difficult to copy or forge

A typical embodiment is described in figure 1, a card 200 comprises a reflective surface 201 in the focal plane of a lenslette array 202. The IR radiation 205 reaching the card will be modulated by the modulator 203 according to the command set by the miniature ASIC 204, which is also embedded in the card. The modulator 203 can be located in front the lenslette array 202 or behind it. It functions as an aperture control. In another embodiment the reflector 201 has a controlled reflection thus functioning also as the modulator 203. The considerations are similar to those of the Internet WiFi application.

Preferably, said modulator comprises an aperture controller for controlling the aperture of said lens.

Preferably, said aperture controller comprises a first layer having transparent stripes interspersed with absorbing stripes.

Preferably, said aperture controller further comprises a second layer having stripes of absorbing material interspersed with transparent regions, said first and said second layers being superimposed on each other.

Preferably, said aperture controller comprises an LCD unit.

Preferably, said aperture controller comprises an PDLC unit.

Preferably, said aperture controller comprises a nano material doped substrate unit.

Preferably, said receiver, and said reflector together comprise a lens having a focal point, and a liquid crystal panel and wherein said liquid crystal panel is located at said focal point.

Preferably, said liquid crystal panel is controllable via associated control circuitry to provide variable reflectance, thereby to provide said modulator.

Preferably, said receiver, and said reflector together comprise a lens having a focal point, and a PDLC screen is located either in front of the lens or at the reflector.

Preferably, said PDLC panel is controllable via associated control circuitry to provide variable reflectance, thereby to provide said modulator.

Preferably, said receiver, and said reflector together comprise a lens having a focal point, and a nano particles doped substrate panel and wherein said nano doped substrate panel is located at said focal point.

Preferably, said nano doped substrate panel is controllable via associated control circuitry to provide variable reflectance, thereby to provide said modulator.

Preferably, said reflector comprises a corner cube.

Alternatively or additionally, said modulator comprises a MEMS optical switch.

Preferably, said MEMS optical switch is a thermal effect MEMS optical switch.

Alternatively or additionally, said MEMS optical switch is an electrostatic force MEMS optical switch.

Preferably, said reflector comprises a liquid crystal panel arranged in patterns of reflecting and non-reflecting regions, and said modulator comprises control circuitry associated with said panel to rearrange said patterns.

The detection system 180, is described in Fig 2:
An IR source 210 transmits a coded IR radiation 205, said radiation is modulated and retro reflected from the card 200 carrying the biometric information stored in the card. The signal is detected at IR detector 212 via a lens 211. The detector is an IR detector, for the relevant wavelength range. In case of 0.9 micron, the detector is a silicon PIN or APD detector. In case of deeper IR, detectors like PbS could be used.
The detected signal is amplified in the low noise amplifier 213 and processed in the processor 214. Processing include pulse shaping, demodulation and verification.
Another module of the detection system is a sensor to detect the actual biometric feature – Voice; face morphometric features; fingerprint etc. The system configuration will change respectively:
Voice – a microphone 216 mounted in the focal zone of a parabolic dish 217 detects the voice signal of the approaching person. This detected voice is processed in processor 218 to extract characterizing voice features and the data is fed to MPU unit 255 for comparison to the IR transmitted stored voice.
The transceiver can combine the acoustic dish 217 and the IR detection lens 211 in a single device

Data may be acquired by the card itself and be part of the signal which modulates the retro reflected beam.

In one embodiment of the invention a card 140 incorporates a microphone 141. The microphone consists of a flexible membrane 142, a printed flat coil 143, and a magnetic layer 144, which have a vertical magnetic field component B. When required, the card owner 190 speaks and emits sound waves 145 and 191. The real time voice signal is digitized and stored in a subunit 150. The password voice signal is permanently stored in a subunit 166. Both signals are fed to the retro modulator 160. The retro modulator consists of a lenslette array 161 and a liquid crystal modulator 162 and a mirror layer 163. The bandwidth of the system is usually low (100 bits/sec or less due to the low bandwidth of the information. As a result simple liquid crystal devices may be utilized although in some cases other modulators may be used such as saturable absorbers.

The gate or protected, site incorporates a transceiver 180, which emits light and detects retro reflected light and a unit, which analyze the stored voice password to the real time signal, both of them were retro reflected.

The embodiment described therein enables the cardholder to talk into the card and transmit a full sentence as a response to a guard request. The card is thereby transformed into a " lying detector".

In case of a morphometric feature, the transceiver 180, as in Fig 3, will comprise a TV camera 219 and a light source 220 to acquire the Image data of the approaching person. The image is digitized in the Frame Grabber 221 and the extracted shape data is sent to the MPU 215 for comparison to the IR transmitted stored image.

In case of fingerprint identification, a remote fingerprint analysis system will be connected to the transceiver 180. The coded data is low bandwidth and hence a low bandwidth retro modulator would suffice.

Other embodiments of the biometric remote identification can be in other portable miniature devices such as a wristwatch; a pen; a PDA or a cellular phone.

Verification could be independent within the transceiver 180, comparing the card-stored data to the extracted data. Other modes could be by interface to a main Data Base.

MAV interface

The low power miniature IR communication channel could be used in MAVs (Micro Air Vehicle) minimizing the power consumption to practically only the Aviation needs. The set-up is shown in Fig 4.

A miniature retro modulator, 240, as explained above, is mounted on the MAV, 241. It has a wide angle, typically 2Π, to assure an effective link regardless of the position of the MAV. A laser beam 242 is tracking the MAV in azimuth and elevation angles. Tracking is implemented using radar or other means for tracking. The laser beam, hitting the MAV is modulated and retro-reflected to carry upstream the stored information. Using the laser a much higher range could be achieved.

Another embodiment refers to an MAV inside buildings. In this case, range is limited and the MAV can interface to a set of transponders spread around the building.

Background on Nano particle doped modulator

Colloidal semiconductor nano crystals (NCs) can be considered as "artificial atoms", due to their qunatized electronic states, which usually obey Hund's state-filling rule

(reaching saturation after accumulation of two electrons per state). These NCs are a class of luminescent chromophores, showing tunable and intense optical transitions that vary with the NCs' size (known as the quantum size effect, QSE). The NCs of the IV-VI compounds (PbS, PbSe) are of particular interest due to their optical activity in the IR spectra regime. PbS and PbSe NCs inherit their unique properties from the corresponding bulk compounds, typified by a narrow direct band gap (0.28–0.40 eV at 300K), high dielectric constant (ε_{∞} =17–24), small electron and hole effective mass (<0.1 m*) and an exciton with a relatively large effective Bohr radius (a_B =18–46 nm). The inter-band optical studies of colloidal PbS, PbSe NCs exhibited a well-defined band-edge excitonic transitions tuning between 0.5–2.5 micron, and nsec lifetime. Due to the Hund rule, an injection of carriers into these "artificial atoms" brings them into saturable state. Thus, the NCs become transparent to the light under saturation conditions and absorbing at non-saturated conditions. In other words, these NCs may act as an optical modulator.

Signal to noise analysis and operating range:

The operating bandwidth and distance of retro modulation modules (named PMRF) in the present invention are governed by two equations:

(1) P(received) = P(transmitted) A * Tr / U^2 * D^2

for the received power level

And

(2) S/N = [r* P (received)]^2 * R / [2e*B*Id*R + 4kTB]

for the receiver signal to noise ratio

Where:

P(transmitted) = Transmitted power , A= PMRF surface area , Tr = overall reflectivity of the PMRF module taking into account the internal transmission , U= transmitter diverging angle (given in radians), D = distance between the transmitter and the retro modulator unit.

And

r = detector sensitivity (amper /watts) , R = detector input resistance , e = electron charge (1.9 X 10^ - 19 coulomb) , B = communication channel bandwidth , Id = detector dark current , k= Boltzman constant (1.38 * 10 ^ - 23) and T = ambient temperature (300 deg cent)) .

Equation (1) expresses the assumption that communication distance is short enough to collect the entire retro reflected energy into the receiver and ignore diffraction of the reflected beam from the PMRF which would have entailed a D^4 dependence in

equation 1. That assumption is correct for PMRF's of 1 mm – 50 mm size range, which are operated from distances of approximately 1-20 m.

In addition to S/N analysis, we show that communication with PMRF modules can actually be performed with very low battery power consumption.

We first analyze the S/N ratio of a small, low band communication channel, which operates from a short distance such as 2 meters:

Assume micro PMRF modules of 1 mm size. Assume that requested bandwidth transmission is 1000 bits/seconds. Assume that the transmitter (which is part of the transceiver) is a single segment 1 Watts 980 nm non-coherent diode lamp that emits scattered radiation from an eye safe 1cm Lambertian (U= ~ 120 degrees) diffuser.

Is it feasible to remotely operate such a miniature communication channel from a distance of 2 meters?

Assuming a liquid crystal modulator of 40% back and forth transmission (ref 1) and 90% mirror reflectivity and 100% modulation depth, we obtain from equation (1) :

P (received) = ~ 2 X 10 ^ -8 Watts (20 nano watts)

The signal to noise ratio in equation (2) will be calculated for a typical PIN photodiode with responsivity r = 0.5 A/W at 850 nm, and 2 nano Ampere dark current.
Assuming a ~ 1000 Ohm load which will enable even faster modulation rate if necessary we obtain a thermal noise (4kTB) much higher than the dark current noise (2eB Id R):

(3) S/N = [r* P (received)]^2 * R / [4kTB] = [(10^ - 8) ^ 2] / [4*(1.38 * 10 ^ - 23) * 300 * 1000] = ~ 5

A signal to noise ratio of 5 provides a communication channel with an acceptable low error bit rate . .

We now analyze a more common scenario:

Assume we consider a wireless Palm PDA, which incorporates a thin 3X3 cm 2 PMRF sheet and surfs the web at a rate of 100kbits/sec. A portable IR non coherent LED lamp units (transceiver) is located at a distance of 10 meters from the PDA. . PIN diodes or avalanche photodiodes are installed adjacent to the IR lamps as in figure 13b. IR Power level is 10 watts for the entire 4XPI solid angle spanned by the transceiver (equivalent to single segment transceiver covered by a Lambertian diffusing surface which provides eye safety conditions).

Assuming the same PIN photodiode as in the previous case leads to the following analysis:

PMRF area is 30X30 ~ 1000 larger than in the previous case.
Distance D is 5 times larger.
Power level is 10 times higher.
As a result P received is 10X1000/ 5^2 = 400 higher than in the previous case.

Assuming the same 1000 Ohms input resistance, the X 100 times larger channel bandwidth (100k Hz vs. 1k Hz) reduces the S/N ratio by 100/400 = 0.25 (or increase by X4). Increasing the load resistance to 10k Ohms will still enable 100k Hz bandwidth and increase the S/N ratio by a factor of X 10. We thereby expect a S/N = 200.

We conclude that a basic PIN based PMRF communication channel will operate with a S/N ratio of 200 from a distance of 10 meters, or S/N ~ 20 from a distance of ~ 30 meters. That inexpensive option is attractive for low-end sites such as cafe or private houses.

The utilization of avalanche photodiodes in high end sites will increase the S/N ratio by few orders of magnitude, allowing operation from a distance of over 30 meters with larger bandwidths.

Battery energy saving analysis:

The only power-consuming component of a PMRF is the modulator. Assuming one is using a fast response liquid crystal technology (ferro electric liquid crystal FLC) for modulation, we may obtain an estimate of the power consumption as follows:

Ferro electric Liquid Crystal (FLC) units consume approximately 30 microamps at 10 Volts operating voltage at a repetition rate of 1 kHz for surface area of approximately 25 X25 mm 2. As a result power consumption is 30* 10 ^ -6 * 10 / 5 = 60 microwatts / cm2 at 1 kbits /sec modulation rate.

In the wireless Internet connection example we have to multiply the power consumption density by the surface area =~ 10 cm2 and by a factor X 100 for utilizing a larger channel bandwidth.

This leads to a PDA power consumption of 60 milliwatts for the over 30 meters communication ranges with a basic PIN photodiode and a S/N ratio of 20. However, the power consumption is dramatically reduced by utilizing a standard avalanche photodiode with a G=X10 gain. Such a gain increases S/N by a factor of G^2=100. By reducing modulation depth to m = 1/10 we preserve the same S/N level while reducing power consumption by a factor of X100 (m^2).

We conclude that a 30 meter, 100kbits/sec PMRF based wireless communication channel is feasible with battery power consumption as low as 0.6 milliwatts !! . That consumption level is 50 times lower than available with microwave based Blue Tooth.

Objectives and Claims

1) An objective of the described method and apparatus is to enable comfortable wireless communication between a PDA user and a local area network or an Internet supplier
And
Said communication is battery energy saving which depletes PDA batteries at a low rate
And
The energy consumption of the PDA batteries resulting from the establishment of said communication is generated by the modulator and not by the communication carrier radiation
And
The PDA operator can locate himself comfortably in a site in a space where the site is far from an electrical outlet or Internet connection outlet.
2) As in 1) , said communication system is passive and PDA is not generating a radiation carrier but rather retro reflecting a radiation carrier.
3) A method and apparatus (or system) for PDA battery energy saving wireless internet communication between a PDA and an internet server or local area network said apparatus comprises of:
A retro modulator, said retro modulator is connected to said PDA and said retro modulator is capable to modulate an optical beam which impinges on the retro modulator with information generated by the said PDA,
And
A transceiver, said transceiver generates eye safe diffused light which essentially covers an entire space such as a room, a cafe space or an airport terminal,
Said transceiver also incorporates a detector which is capable of demodulating upstream-modulated light which is modulated by said retro modulator,
And
Said transceiver incorporates a stand which enables to locate it any convenient place in the room (or space) such as on a table, or said transceiver incorporates an element which enables to fix the transceiver to a convenient site such as on a wall or a ceiling ,
And
Said transceiver incorporates a mean to communicate by WiFi or diffused infrared to an Internet or LAN energized connection and to provide the downstream information to the PDA.
4) As in any of 1-3, said retro modulator incorporates at least one cat eye lens.
5) As in any of 1-4, said retro modulator incorporates a lenslette array panel.
6) As in any of 1-5 , said retro modulator incorporates more than one lenslette array panels.
7) As in any of 1-6, said retro modulator can be rotated or reoriented.
8) A retro modulator connected to a PDA. Said retro modulator is operated by the PDA batteries.
9) As in any of 1-8, said retro modulator incorporates at least one liquid crystal shutter.
10) As in 9), said liquid crystal shutter is a PDLC.
11) As in 8) said retro modulator incorporates nano spheres in a transparent medium, said nano spheres are liquid crystals or optical satuarble absorbers.

12) As in 8) said retro modulator is covered by one or more band pass filters.
13) As in 8) said retro modulator is modulated by a MEMS device in the focal plane.

14) An optical transceiver as in 3), said transceiver comprises of an array of adjacent transceivers, each transceiver enabling communication with a sub area in the room.
15) An optical transceiver, said transceiver incorporates a detector, said transceiver receives and demodulates light which originates from the transceiver and is retro reflected from a retro modulator which is connected to a PDA.
16) As in 15, said transceiver incorporates a narrow band filter.
17) As in any of 1-16, said communication channel transmits an e-mail.
18) As in any of 1-17, said transmission rate is between 100 bits/seconds and 10 mega bits /seconds.
19) A PDA, which is connected to an optical retro modulator and transmits an e mail.
20) As in any of 1-19, the distance between PDA and transceiver is between 1 meter to 70 meters.
21) As any of 1-20, said retro modulator is not operated by PDA battery but rather by its own independent battery, thereby saving PDA battery energy and also retro modulator battery energy.
21) An Internet communication system as in 3) which incorporates more than one transceiver.
22) A transceiver which incorporates an array of multiple optically diffused radiation areas and adjacent areas which incorporate receivers, said receivers receive radiation retro reflected from a retro modulator, said array is transportable and can be located on a furniture, said array can transmit an RF or IR received signal from retro modulator to a nearby internet link.
23) An optical transceiver or an array of adjacent transceivers, said transceiver constantly emits low power radiation, said radiation from at least one transceiver is automatically increased as the result of the detection of retro reflected light which results from the presence of a retro reflector in the vicinity of the transceiver, thereby enabling radiation only to periods of time when user wishes to establish communication.
24) A battery saving remote control unit for a device such as a TV set, said control unit comprises of a retro modulator of light emitted from a transceiver located in a room or inside the device such as the TV set , said control unit incorporates information such as information regarding the browsing of programs, or turning ON/OFF the TV set or the selection of programs.

25) A battery saving remote control as in 24 and 23.
26) A battery less remote control using solar cells as the energy source.

27) A battery saving electronic remote identification card , said identification is based on biometric information (such as voice identification or facial identification) which is stored in the card , said identification card incorporates an optical retro modulator,
and
a transceiver array installed in the vicinity of a site to be protected , said transceiver incorporates an emitter which emits light , said light is retro reflected and modulated by said identification card and said retro reflected light is detected by the receiving part of the transceiver
and

said detected signal is fed to an analyzing unit which compares the biometric information stored in the card to actual real time biometric information obtained from the card owner .

28) As in 27, said real time biometric information obtained from the card owner is detected by the card and delivered to the analyzing unit by said retro modulation process.

29) As in 27 and 28, said biometric information is card owner voice properties and identification card incorporates a microphone, which detects card owner voice and said microphone can be any of a coil or capacitive or MEMS microphone.

30) As in 29, said smart card can transmit long sentences as a response to request by a gard , thereby serving as a lye detector.

30) As in 27 and 28, said biometric information is card owner fingerprints and identification card incorporates an optical viewer, which detects card owner fingerprints.

31) Use of a parabolic dish for both IR and acoustic detection.

32) Local comparison of IR transmitted stored biometric data to locally extracted biometric data.

33) Comparison of IR transmitted biometric data to a main Data Base.

34) Communication to MAV using retro reflection of laser light.

35) Communication to indoor MAV using a set of transponders.

36) Retro modulator via the USB connector of a laptop/portable computer.

Incorporation by reference

Previous International Patent Application No. WO02/32150, filed October 11, 2001, is hereby incorporated by reference herein.

Claims

We claim:

1. Infra-red retromodulation apparatus, system or method, substantially as hereinbefore described with reference to the accompanying drawings.

2. Remote identification apparatus system or method via infra-red signaling, substantially as hereinbefore described with reference to the accompanying drawings

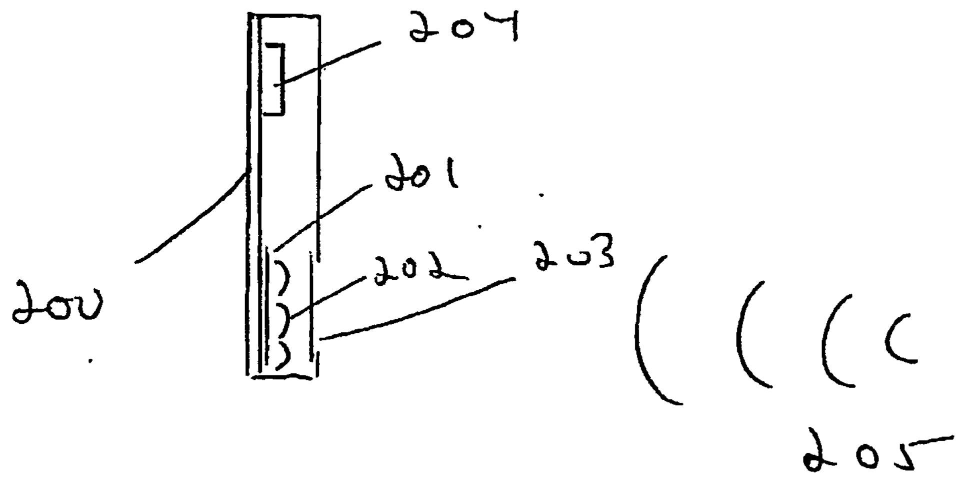

204
201
200
202
203
205

Fig 1

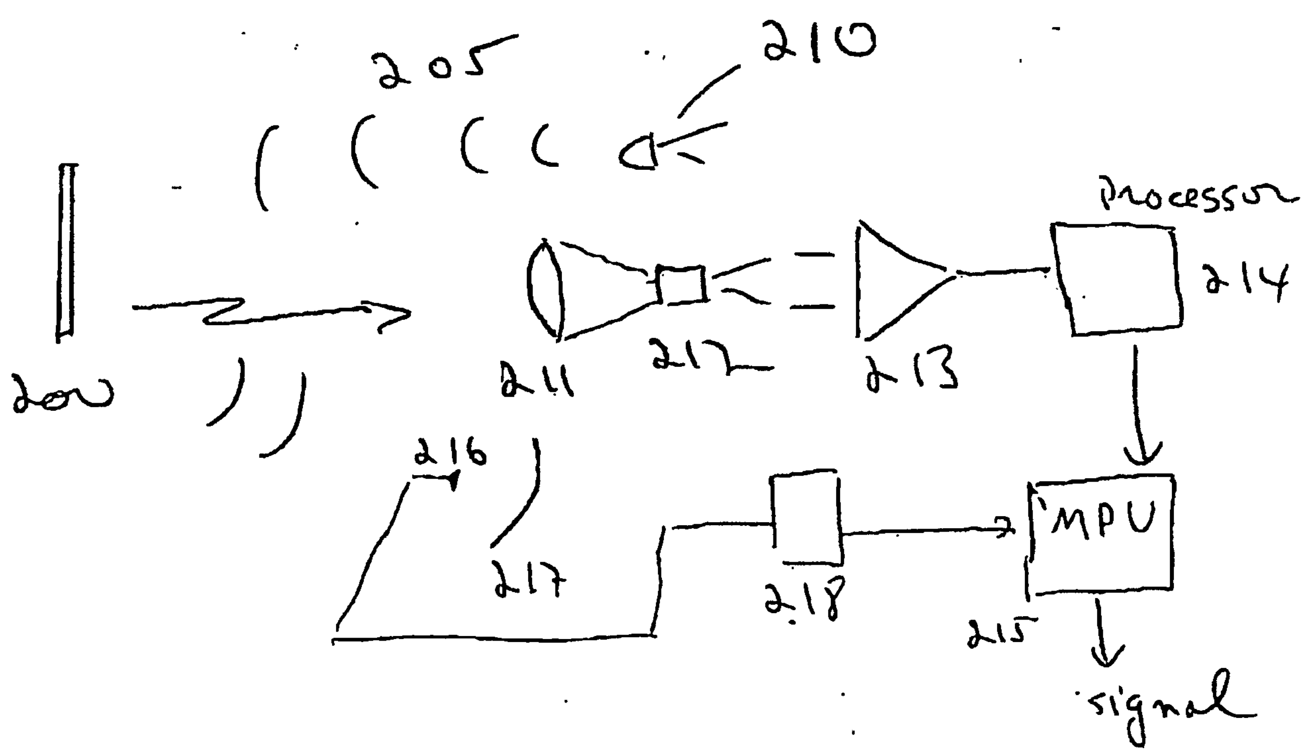

205
210
Processor
214
200
211
212
213
216
217
218
MPU
215
signal

Fig 2

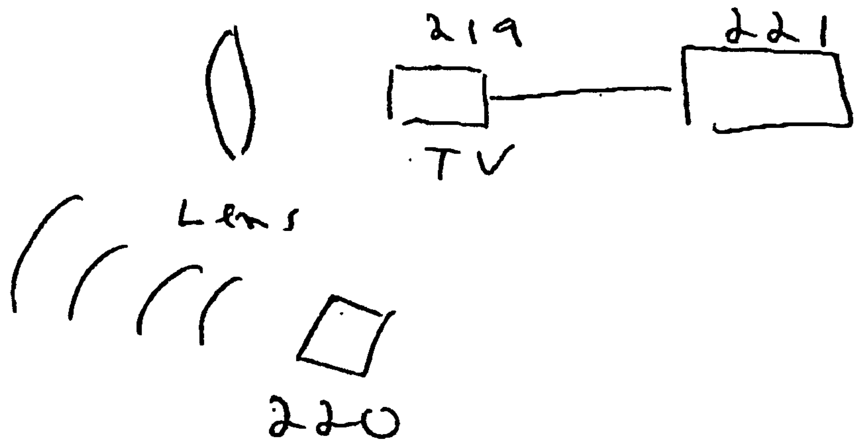


Fig 3

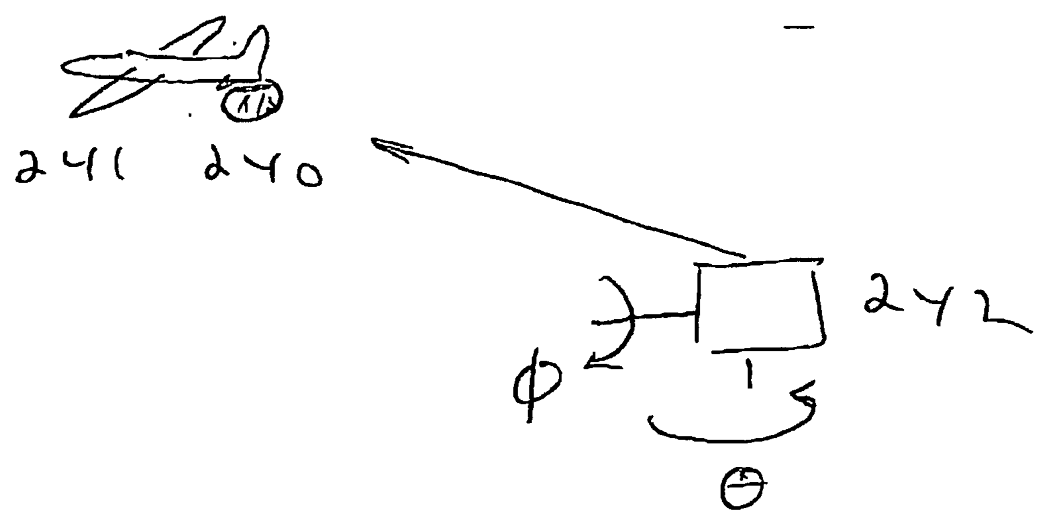
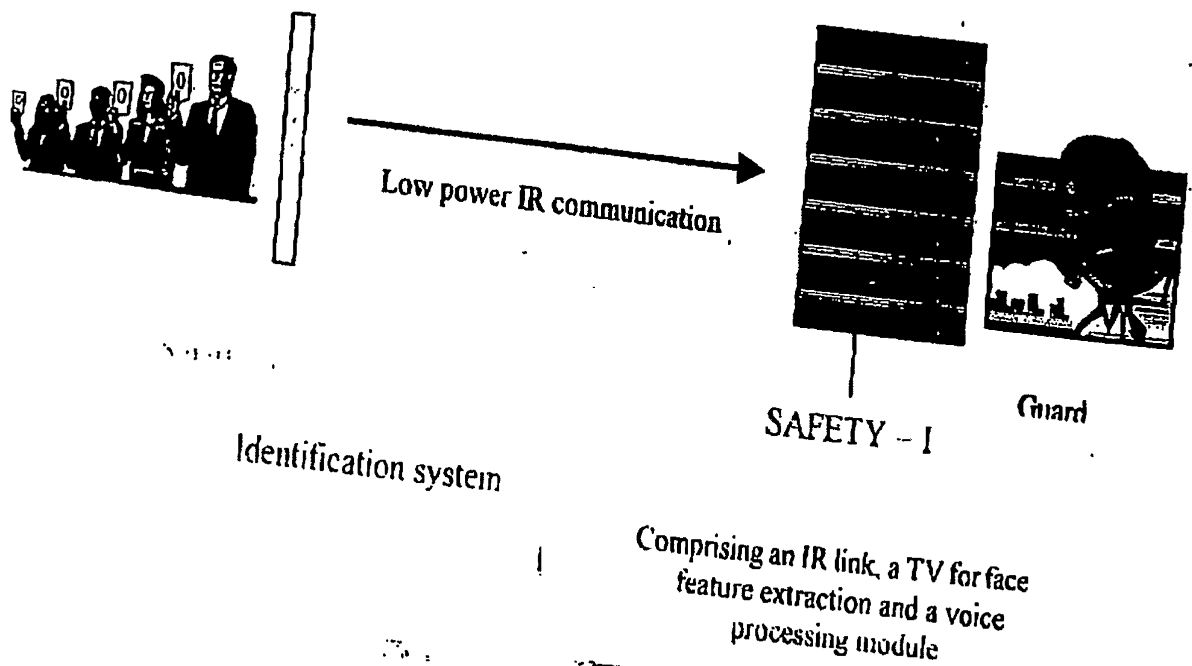


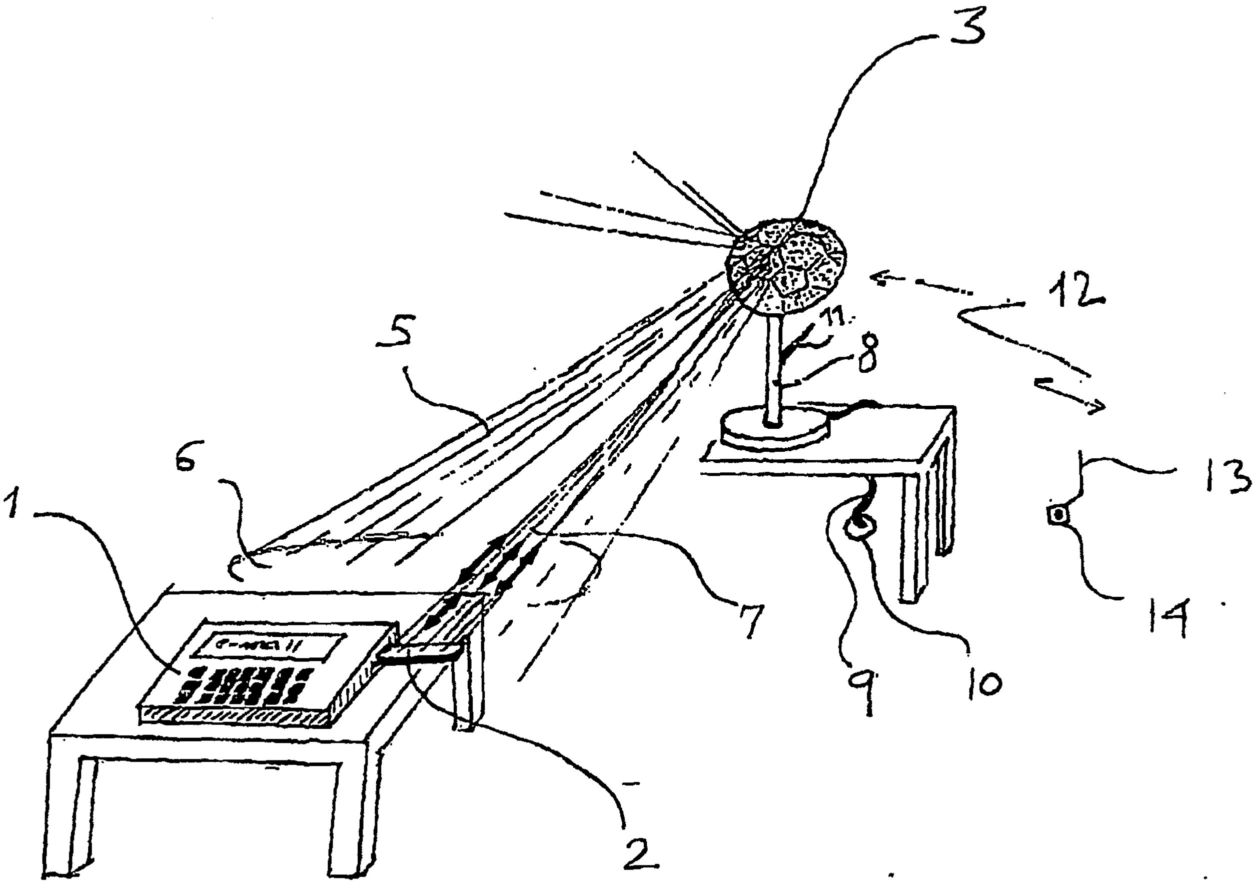
Fig 4.

4



Low power IR communication
SAFETY – I
Guard
Identification system
Comprising an IR link, a TV for face feature extraction and a voice processing module

Fig 5



figare 10

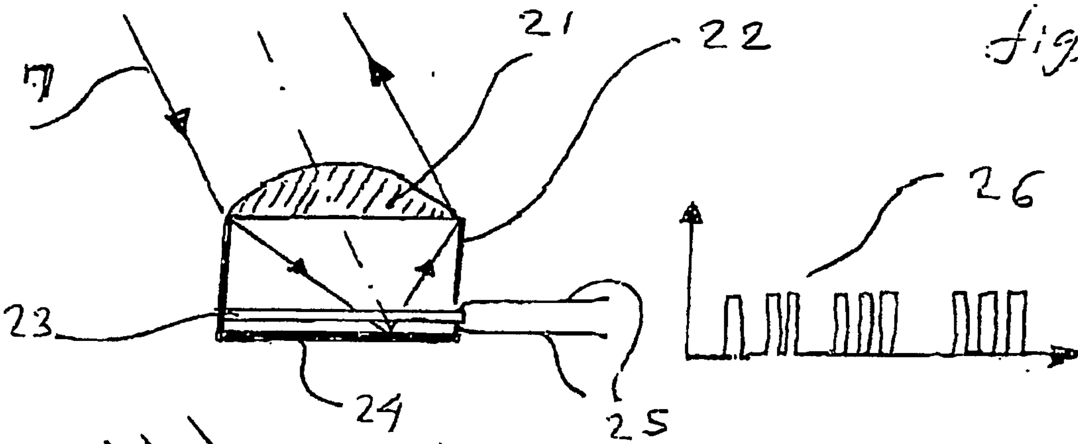


figure 11a

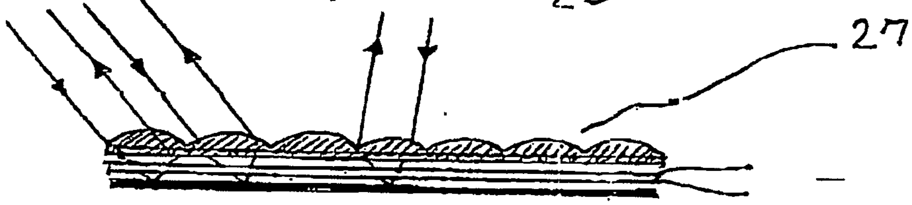
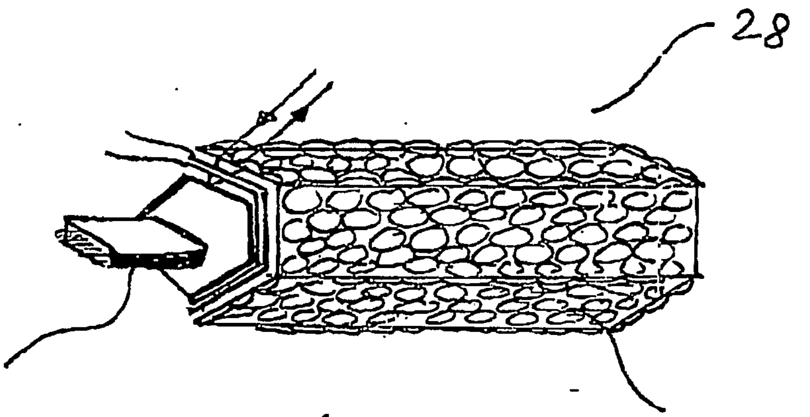


figure 11b



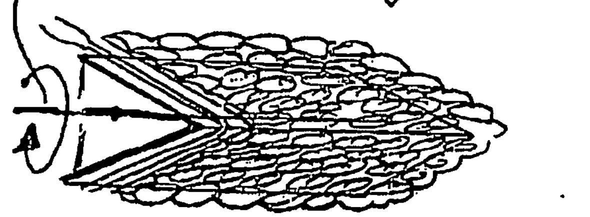


figure 11c

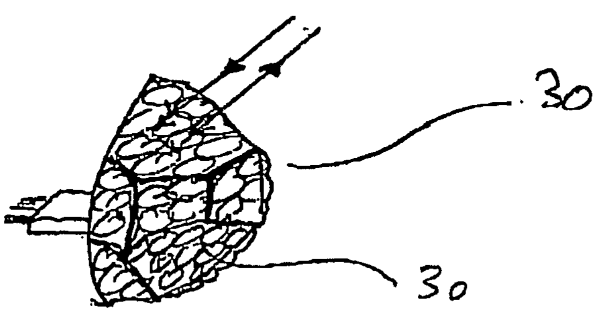


figure 11d

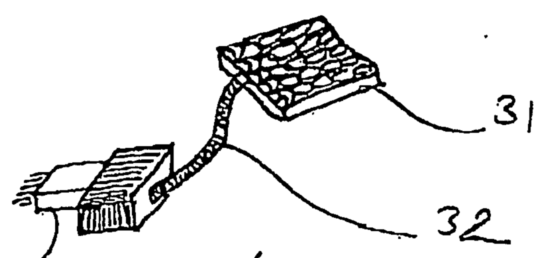
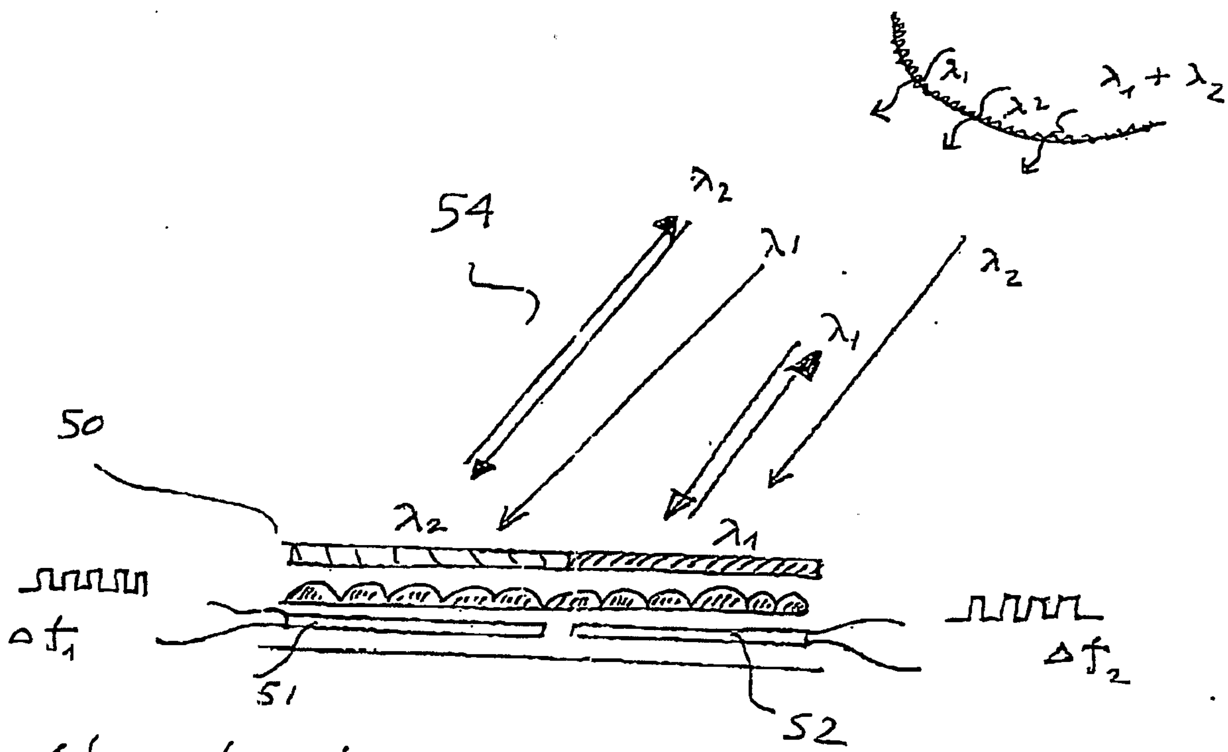


figure 11e

figure 11



$\Delta f = \Delta f_1 + \Delta f_2$

Figure 12

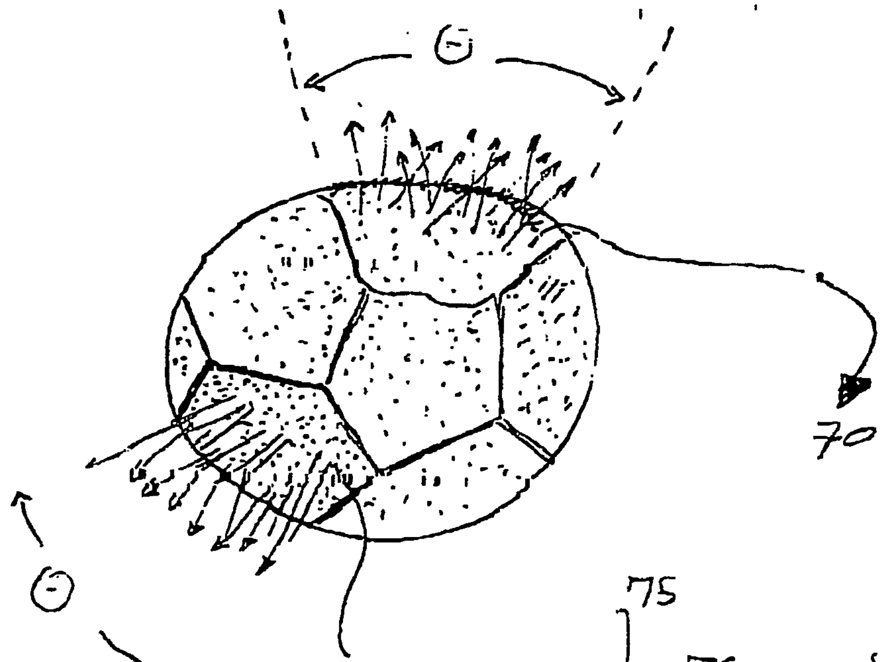


figure 13a

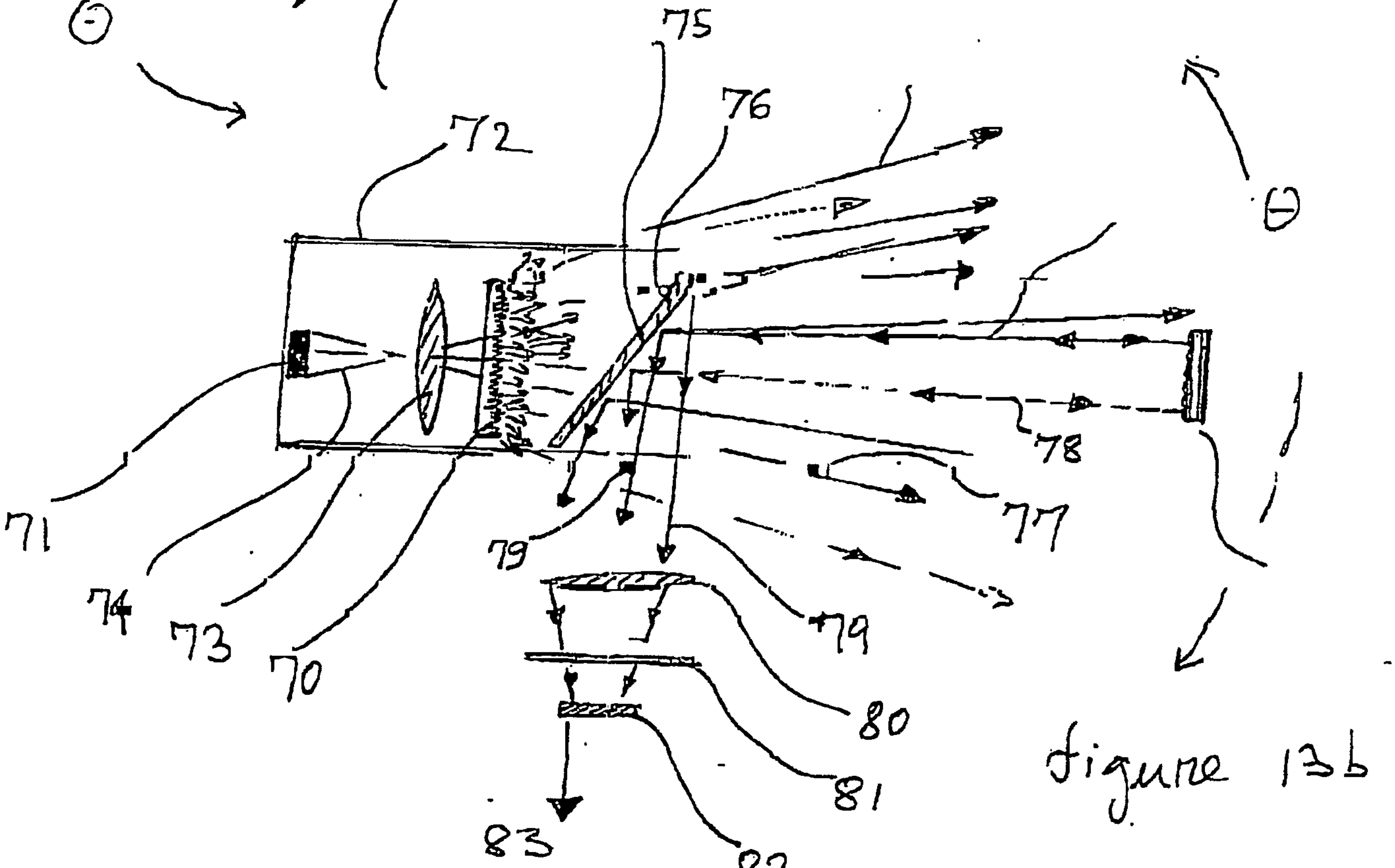


figure 13b

figure 13

figure 14 a,b.

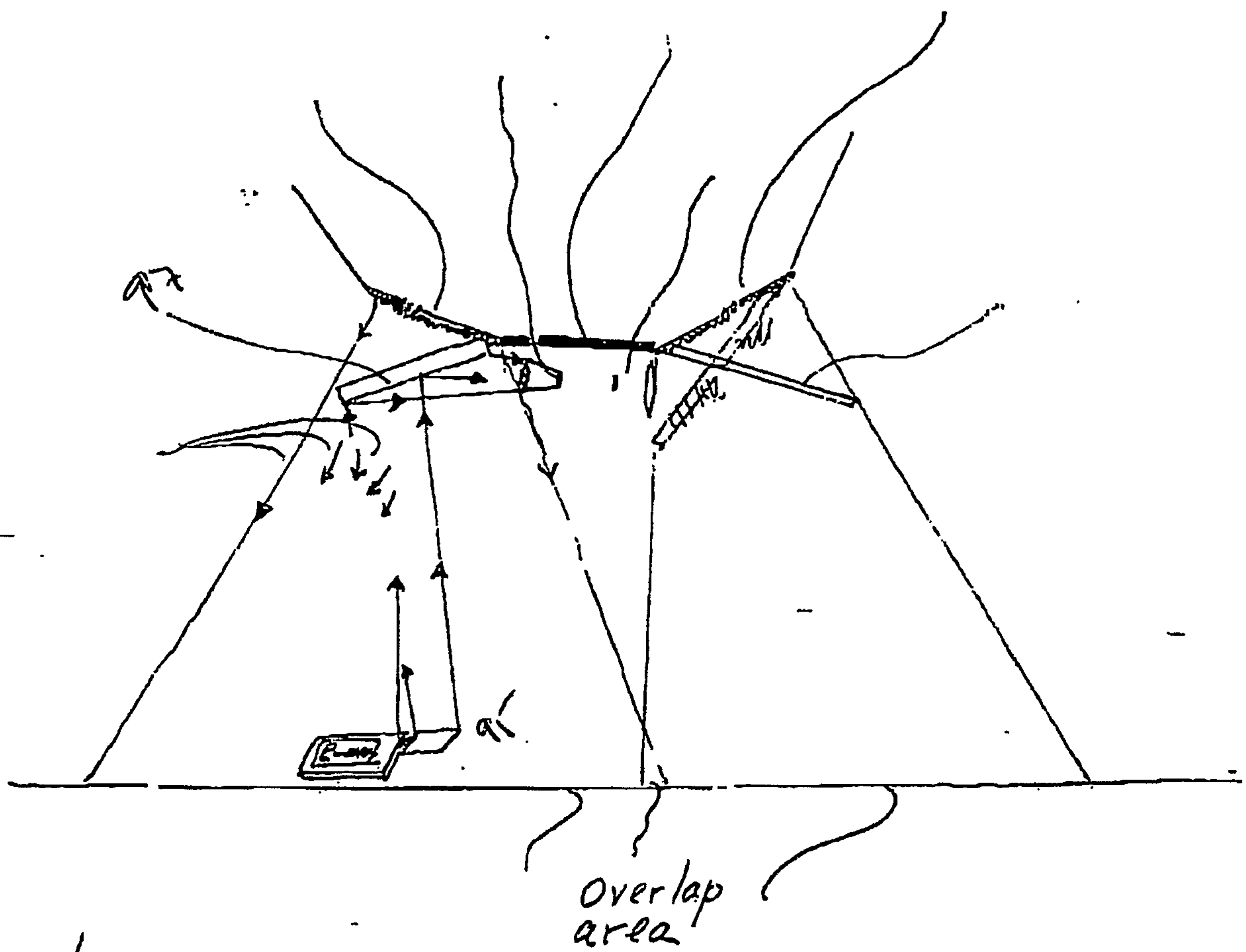


figure 14 a

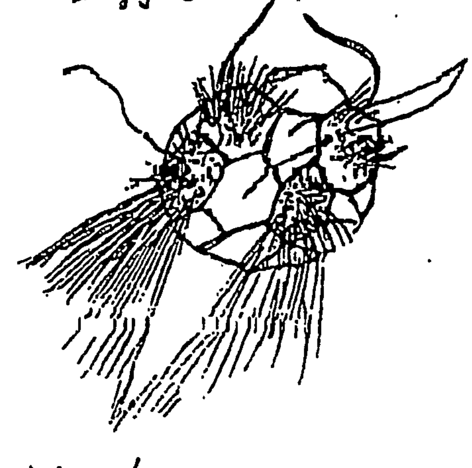


figure 14 b

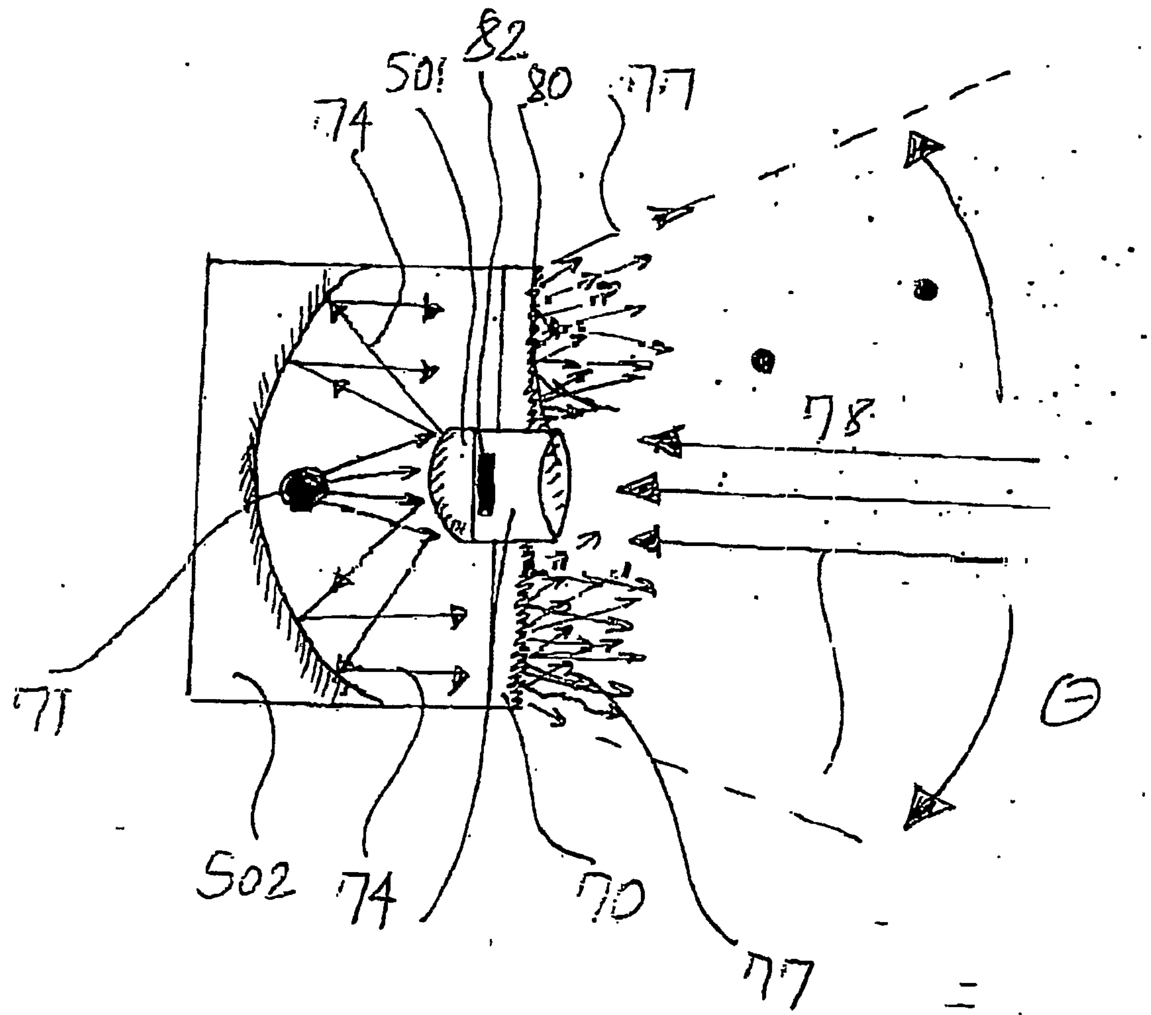


Figure 14c

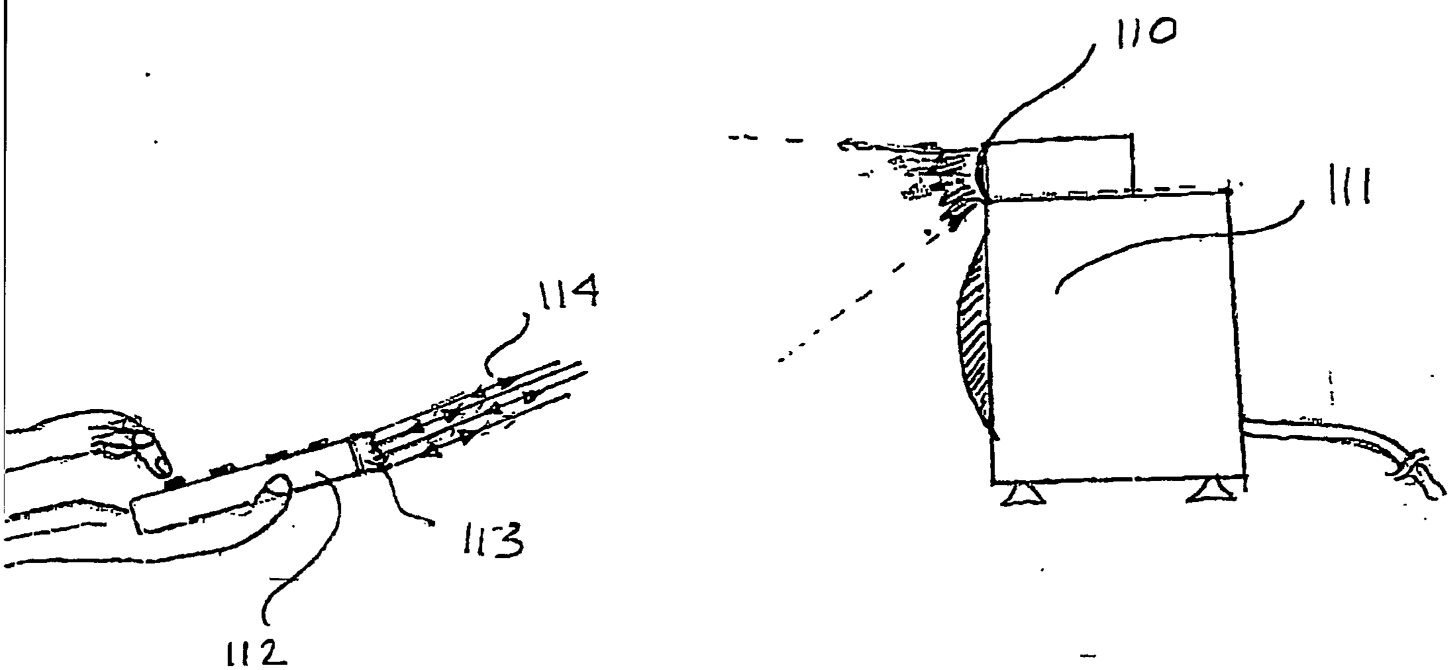


Figure 15

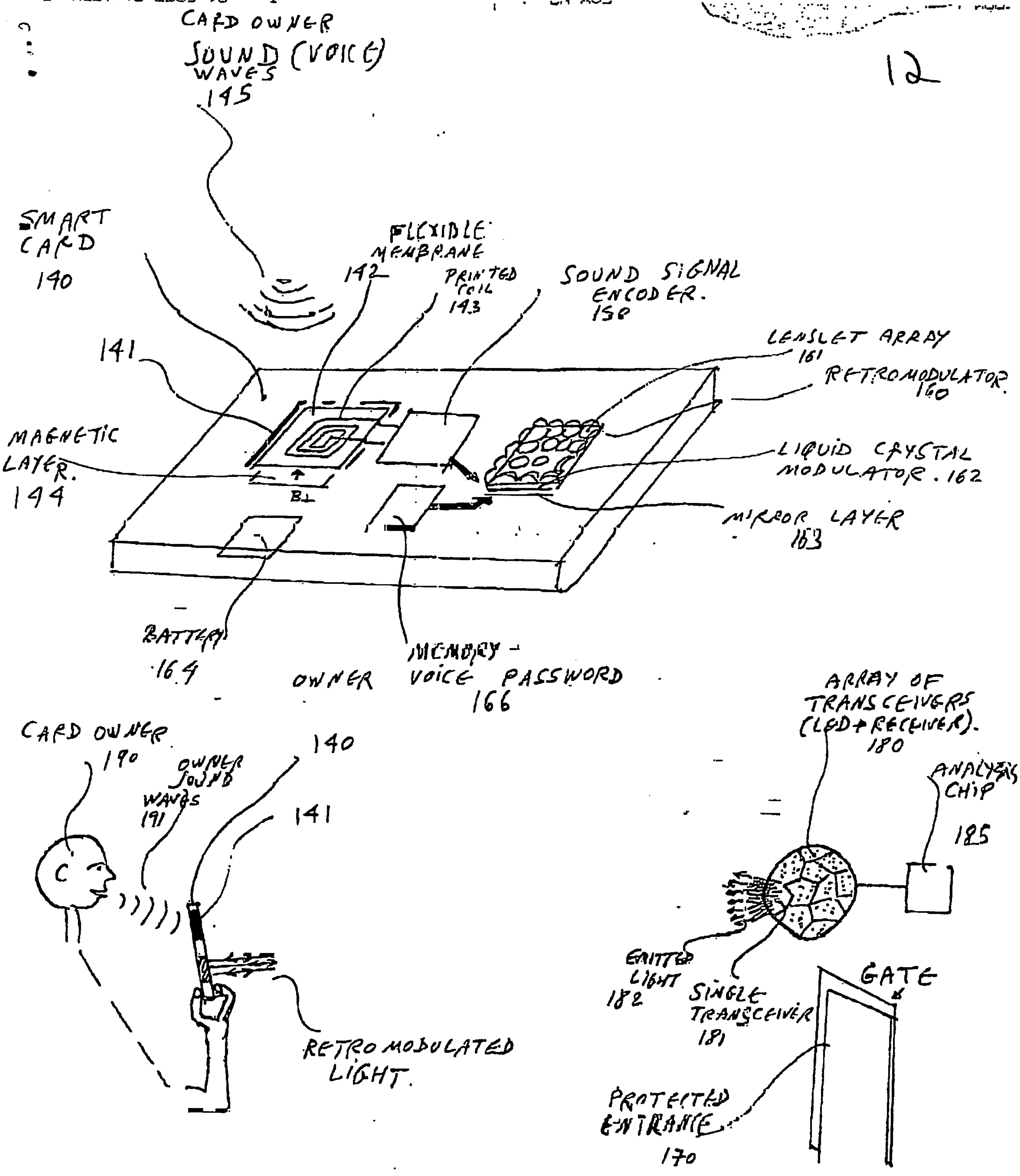

CARD OWNER
SOUND (VOICE) WAVES
145
SMART CARD
140
FLEXIBLE MEMBRANE
142
PRINTED COIL
143
SOUND SIGNAL ENCODER.
150
LENSLET ARRAY
161
RETROMODULATOR.
160
141
MAGNETIC LAYER.
144
B⊥
LIQUID CRYSTAL MODULATOR. 162
MIRROR LAYER
163
BATTERY
164
MEMORY -
OWNER VOICE PASSWORD
166
CARD OWNER
190
OWNER SOUND WAVES
191
140
141
RETROMODULATED LIGHT.
ARRAY OF TRANSCEIVERS (LED+RECEIVER).
180
ANALYSIS CHIP
185
EMITTED LIGHT
182
SINGLE TRANSCEIVER
181
GATE
PROTECTED ENTRANCE
170

figure 16